Current specification for High Performance Concrete (HPC):

See Section 903.05 of NJDOT 2007 Standard specifications:
http://www.state.nj.us/transportation/eng/specs/2007/Division.shtml

Requires Chloride Permeability Testing (AASHTO T 277) with criteria of <1000 Coulombs for design and <2000 Coulombs for production.

AASHTO TP 95 – Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration was adopted by AASHTO in 2011. Florida DOT spearheaded the use of this standard as an indicator of the permeability of concrete. Virginia DOT is in the process of adopting this test method as a screening tool for HPC.

NJDOT would like to consider replacing T 277 with TP 95 for HPC specifications. TP 95 is a much quicker test and takes little sample preparation. T 277 is a 6 hour test and the sample preparation is extensive. Due to testing simplicity NJDOT, would like to move to the new test method but only if we can be assured that we will still be getting good quality (low permeability) concrete for our HPC.

This research is proposed to look at the viability of replacing T 277 with TP 95 in NJDOT's specification for HPC.

NJDOT – Bureau of Materials routinely tests HPC using T 277. Additional cylinder(s) can be obtained from the field for the researcher to test using TP 95.

903.05 HIGH PERFORMANCE CONCRETE (HPC)

903.05.01 Composition

Produce HPC conforming to the composition requirements specified in 903.03.01, except for the following:

1. When using more than 1 admixture, ensure that they are compatible. If using admixtures from different manufacturers, submit letters from each manufacturer certifying that their admixtures are compatible with all others in the mix design.
2. Pozzalonic material maximum percentage limitations specified in 903.01 and 903.02.03 are waived for HPC mix designs.
3. In the design of HPC, in order to achieve the desired resistance to chloride penetration, provide an appropriate pozzalonic or other cementitious material, such as silica fume, fly ash, or slag in the mix design.
4. Do not use silica fume as a sole material to achieve the desired resistance to chlorides. Do not use more than 5 percent of silica fume by weight of the total cementitious material. If using fly ash in conjunction with silica fume, use 10 to 15 percent fly ash by weight of the total cementitious materials. If using slag in conjunction with silica fume, use up to 40 percent slag by weight of the total cementitious materials.

903.05.02 Mix Design and Verification

Design an HPC mix that conforms to the requirements in Table 903.05.02-1. Submit a report documenting these results to the ME. Obtain the results of these standard tests from an AASHTO accredited testing agency that is accredited for the test being performed. Design mixes according to the HPC-1 criteria for use in bridge decks, parapets, and bridge sidewalks. Design mixes meeting the HPC-2 criteria for use in pier column protection.

Table 903.05.02-1 Design and Verification Requirements for HPC

Performance Characteristic	Test Method	Requirements	
		HPC-1	HPC-2
Scaling Resistance[1] @ 50 cycles (visual rating of the surface, maximum)	ASTM C 672	3	–
Abrasion Resistance (average depth of wear in inches, maximum)	ASTM C 944	–	0.04
Freeze-Thaw Durability (relative dynamic modulus of elasticity after 300 cycles, minimum)	ASTM C 666 Proc. A	80%	80%
Chloride Permeability[2] @ 56-days (coulombs, maximum)	AASHTO T 277	1000	1000
Compressive Strength[3] @ 56-days (pounds per square inch, minimum)	AASHTO T 22	5400	5400
Water-Cement Ratio (maximum)	–	0.40	0.40

[1] For the scaling resistance testing, moist cure specimens for 14 days and then air cure for 14 days.

[2] If the chloride permeability requirement has been achieved in 28 days, consider the chloride permeability acceptable. If the required chloride permeability is not achieved in 28 days, test the HPC sample at 56 days.

[3] If the compressive strength requirement has been achieved in 28 days, consider the strength

acceptable. If the required compressive strength is not achieved in 28 days, test the HPC samples at 56 days.

At least 90 days before the planned start of the concrete placement, submit the mix design to the ME for approval and verification as specified in 903.03.02. Include the results of the required performance testing in the submission.

In addition to verifying the compressive strength of the HPC mix, the ME will verify the chloride permeability testing according to AASHTO T 277. Submit 4 additional cylindrical samples, having a 4-inch diameter and a length of at least 8 inches, to the ME for this verification testing. The ME will average the values of tests on 2 specimens for each mix design.

903.05.03 Mixing

Mix HPC concrete as specified in 903.03.03. During production, do not change the components of the mix in any way from the approved mix design. If the components must be changed, redesign and re-verify the mix.

903.05.04 Control and Acceptance Testing Requirements

With the exception that the ME may perform compression testing at 56 days, the ME will enforce the requirements specified in 903.03.05 for control and acceptance testing of non-pay adjustment Class A concrete in the fabrication of the HPC elements.

Produce HPC that conforms to the acceptance testing criteria in Table 903.05.04-1.

Table 903.05.04-1 Acceptance Requirements for HPC

Performance Characteristic	Test Method	Requirement
Percent Air Entrainment[1]	AASHTO T 152	6.0 ± 1.5 (No. 57/67 Aggregate) 7.0 ± 1.5 (No. 8 Aggregate)
Slump (inches)[1, 2]	AASHTO T 119	3 ± 1
Chloride Permeability @ 56-days[3, 4] (coulombs, maximum)	AASHTO T 277	2000
Compressive Strength @ 56-days[5] (pounds per square inch, minimum)	AASHTO T 22	4400

[1] If using a Type F or G admixture, change the Slump and Air Content values for the HPC as follows:

[1.1] Slump: 6 ± 2 inches

[1.2] Air Content: increase both the target value and tolerance percentages by 0.5

[2] For slip-formed parapet, design and produce a mix with a slump of 1 ± 1/2 inch.

[3] The ME will not test for the chloride permeability requirements for HPC used for Items other than bridge decks.

[4] For chloride permeability testing, the ME will mold 4 additional cylinders, taking 2 cylinders each from 2 randomly selected delivery trucks for testing at 56-days.

[5] For compressive strength testing, the initial rate for the HPC is 6 per lot. The retest limit is 4400 pounds per square inch.

The ME will test 2 specimens for chloride permeability and will average the results of the 2 specimens to determine the test result. The ME will perform 2 tests on each lot from samples taken from 2 randomly selected delivery trucks. The lot is eligible for 100 percent payment provided that the test results are equal to or below 2000 coulombs.

If, upon testing at 56 days, 1 or more individual test results exceed 2000 coulombs, the RE may:

1. Require that the Contractor remove and replace the defective lot, or
2. Allow the Contractor to submit a corrective action plan for approval.

Surface Resistivity Survey

State	Has your DOT evaluated this technology?	Has your DOT implemented any requirements based on this technology	If you have implemented requirements please attach them to your response.
Alabama	No	no	N/A
Alaska			
Arizona	No	No	N/A
Arkansas			
California	No	No	N/A
Colorado	CDOT participated in the round robin testing program for the develop of the procedure with a loaner gauge from FHWA	No	N/A
Connecticut	No	No	N/A
Delaware			
Florida			
Georgia			
Hawaii			

Surface Resistivity Survey

Idaho	Idaho plans to start evaluating TP95-11 this summer. Plans are for in house testing with a potential outside research project also. Once the research is complete we anticipate adding a requirement to various concrete specifications.		
Illinois	ILDOT has not fully evaluated this technology.	ILDOT has not implemented any requirements based on this technology	N/A
Indiana			
Iowa			
Kansas	Yes	No	N/A
Kentucky	No	No	N/A
Louisiana	Yes	Yes	Documents were attached to email.
Maine	Yes. We have been conducting side by side testing of the SR and RCP test for over a year.	Not yet.	N/A
Maryland			
Massachusetts			
Michigan			
Minnesota	Limited evaluation- plan to do more extensive evaluation this summer 2013. MnDOT has purchased 4 surface resistivity probes.	Not at this time	N/A
Mississippi	No	No	N/A
Missouri	MoDOT has not evaluated this technology	No	N/A
Montana	Not yet	No	N/A

Surface Resistivity Survey

Nebraska	Yes	Nebraska uses this technology for research purposes (new mix designs)	Nebraska uses (SRI) for mix design permeability information.
Nevada	Yes	NO	N/A
New Hampshire	Yes, NH performed SRT and Rapid Chloride Penetration testing on multiple batches of variety of mixes to develop a correlation curve. The results matched with the Louisiana work, which became public shortly before our work was completed.	Yes	We revised our concrete specifications in January of this year to adopt the SRT test method. See Attachments in Attachments column.
New Jersey	No	No	N/A
New Mexico			
New York	Yes, NYSDOT is familiar with the technology. NY is a participating member along with your state on the AASHTO Technology Implementation Group for implementation of the Surface Resistivity meter.	We have not presently.	

Surface Resistivity Survey

North Carolina	It was recently used in a Research Project on Lightweight vs. Normal weight decks we funded	NO	N/A
North Dakota			
Ohio			
Oklahoma	No	NO	N/A
Oregon	No	No	N/A
Pennsylvania			
Rhode Island	In the process of evaluating	No	N/A
South Carolina	No	No	N/A
South Dakota	We are in process of purchasing equipment and starting an evaluation	No	N/A
Tennessee			
Texas	No	No	N/A
Utah	No, not formally	No	N/a
Vermont			

Surface Resistivity Survey

Virginia	Yes	Yes	See link in email
Washington			
West Virginia			
Wisconsin			
Wyoming			

Surface Resistivity Survey

If you haven't implemented requirements, do you plan to?	Links or Attachments	Links or Attachments 2
N/A	Attachment 1	Attachment 2
At this time, the answer to all four is no. However, we have performed AASHTO T-277 "Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration" for concrete in the higher elevations in Arizona/ In the future we plan on researching high performance concrete for the high country where they use de-icing products and this test method may be useful.		
California DOT does not plan to implement any requirements based on this technology.		
We have no plans to use this method at this time. We only require ASTM C1202 testing on trial mixes for bare concrete bridge decks. We do not monitor the concrete's permeability in the field. But we are moving away from requiring ASTM C1202.		
Not being discussed at this time.		

Surface Resistivity Survey

N/A		
At this point we are evaluating and may consider implementation.		
Yes		
No		
N/A		
We plan on beginning pilot specifications in 2013.		
We hope to determine how best to implement and potentially look at the 2014 construction season.		
We're considering how to apply the technology.		
N/A		
We plan to start evaluating this technology sometime this summer		

Surface Resistivity Survey

No not at this time.		
The FHWA Testing trailer was here last summer on one of our projects in Reno and performed both C1202 and the surface resistivity tests. The test results compare very nicely. We plan to borrow the equipment from the FHWA and evaluate further. Currently we use the "Prove-it" permeability system for running C1202. Should the surface resistivity meter show signs of producing consistent results, there is a possibility we may recommend using it. The time saving, 5 minutes vs. 2-3 days, alone is worth looking into it.		
N/A	Attachment 1	Attachment 2
NJ is planning on looking into this test method and possibly adopting it.		
We have long term intentions to do so as we attempt to migrate towards more performance based specification requirements in the future, in addition to trying to better streamline our laboratory testing/evaluation process.		

Surface Resistivity Survey

Still evaluating, no real time frame.		
Yes. We are in the process of purchasing the equipment. Our initial evaluation will focus on bridge deck concrete.		
Perhaps in the future. Currently we use AASHTO T277 to correlate chloride penetration.		
Yes, if the evaluation comes out favorably.		
N/A		
Yes		
The use of a performance spec will not be included in our 2014 Specifications, but we are always looking for opportunities to improve concrete quality in cost-effective ways. So we are interested and will continue to consider this technology as a possible avenue for improvement.		
It is possible that the test my be referenced as we continue to seek to develop Concrete Performance specifications.		

Surface Resistivity Survey

We use AASHTO TP95 routinely as an acceptance method. We found that we could improve the reproducibility of the test method if we kept the sample saturated surface wet during testing. Also, if the accelerated curing method is used (which we do), placing the cylinder into a room temperature water bath until cylinder reaches a room temperature before testing reduces potential variability.	Attachment 1	Link 1